

## CHAPTER 2

### CRITERIA AND STANDARDS

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#### 2-1. Introduction.

This chapter establishes criteria and standards for conducting LCC-based economic studies as an integral part of the design of facilities in the MCP. These criteria and standards apply to all Headquarters, Department of Army (HQDA) elements and all field operating activities (FOAs) having Army construction design responsibility. They stem from requirements of three types:

*Type 1.* A basic requirement established by the Department of Defense Construction Criteria Manual (DoD 4270.1-M) for general design applications.

*Type 2.* Special requirements established by statute or by executive order for specific design applications such as energy-saving designs and wastewater treatment facilities.

*Type 3.* Special requirements established within the appropriate DoD headquarters office for one-time or limited application. Economic studies undertaken in response to requirements of type 1 are to be conducted in accordance with the provisions of paragraph 2-2 below and are referred to herein as *general economic studies*. Economic studies undertaken in response to requirements of types 2 and 3 are to be conducted in accordance with the provisions of paragraphs 2-3 through 2-6 below and are referred to as *special directed economic studies*. The criteria and standards for both general and special directed economic studies are illustrated by example in chapters 3 to 6 and appendix A, and implementation guidelines are presented in those chapters. Any further clarification and any additional guidelines that may be required may be obtained by request, through normal channels, to HQDA (DAEN-ECE-G), WASH DC 20314-1000.

##### *a. General economic studies*

(1) *Requirements.* DOD 4270.1-M specifies that economic studies be conducted routinely as part of the design process for all military facilities and that these studies consider the LCC of the facilities. Moreover, the provisions of DOD 4270.1-M cover the evaluation of design alternatives throughout the facilities acquisition process—from early planning stages through construction—and apply to both initial-design decisions and design-modification decisions. Consequently, LCC-based economic studies are required in support of pre-design studies, value

engineering activities, and preparations for major construction modifications, as well as in support of concept and final design.

(2) *Objectives.* The overall objective of a general economic study is to determine the relative economic rankings of all design alternatives under consideration. For most design features, standard practice calls for the designer to select the alternative that is to be implemented; in such cases the principal specific objective of the study is to identify the one design alternative that promises to be most economical for the application at hand. For those design features where standard practice calls for the construction contractor to make the selection (from a list of approved alternatives provided by the designer), the principal specific objective of the study is to identify the least economical of the various design alternatives under consideration, so that they may be proposed for deletion from the list of options provided in the project documents, in accordance with normal procedures for deviations.

(3) *Basic criteria and standards.* Basic criteria and standards for the conduct of all economic studies by and for the Department of Army are contained in AR 11-28, Economic Analysis and Program Evaluation for Resource Management. This technical manual is consistent with AR 11-28 but is limited to the design of individual MCP facilities.

##### *b. Special directed economic studies.*

(1) *Requirements and sources.* The broad, general requirements for LCC studies may be supplemented from time to time by special economic-study requirements of more limited scope. Such special study requirements generally are either higher-authority requirements or HQDA or Office of the Secretary of Defense (intra-DOD) requirements.

—Higher-authority requirements are those established by higher authority than the Department of Defense—generally by statute or executive order and generally for government-wide or MCP-wide application. Requirements of this type are currently in effect with regard to energy-conservation efforts—general efforts required for all new Federal facilities and special efforts to make use of solar energy and other renewable energy sources

that are required specifically for MCP facilities—and the design of all new wastewater treatment facilities. These requirements, which are intended for permanent application, are addressed in paragraphs 2-3 to 2-5.

- DOD requirements for special economic studies are usually intended for only one-time or limited application. Some are limited to a single MCP project or to several closely related projects in the MCP. Others are limited to the projects in a single program year. Such requirements are addressed in paragraph 2-6.

(2) *Objectives.* The objectives of special directed economic studies generally depend on the source.

- Studies directed by higher authority are usually required to help insure the attainment of a newly established national goal, such as energy conservation or the development of innovative wastewater treatment technology.
- One-time or limited intra-DOD directed studies may be required for various reasons: to collect supporting data requested by a congressional committee; to insure that a certain type of study is conducted for a particular project or project type; to encourage consideration of a wide variety of alternative designs for a design feature that has been found to be a maintenance and repair problem; to evaluate the effect of a proposed change in criteria on the design of a particular type of facility; and so on.

(3) *Criteria.* The criteria and standards governing the conduct of special directed economic studies are presented in paragraphs 2-3 to 2-6.

- Paragraphs 2-3 and 2-4 address the special economic studies required by statute for energy conservation—i.e., for the use of extraordinary energy-saving design initiatives to conserve energy in new Federal facilities. The focus in paragraph 2-3 is on those general efforts to conserve non-renewable forms of energy that are required of all new Federal facilities. The focus in paragraph 2-4 is on those special efforts to utilize solar energy and other renewable energy sources—in a passive as well as in active sense—that are required specifically of MCP facilities.

- Paragraph 2-5 addresses special economic studies for the application/im-

plementation of innovative/alternative wastewater treatment technology.

- Paragraph 2-6 addresses special intra-DOD directed economic studies.

Each type of special study—whether of higher authority or DOD origin—is to be conducted as described in this manual with one exception: It will generally not be necessary to conduct a completely new, full-scale special economic study if the relative rankings of the various alternatives under consideration have already been established for similar design conditions, in accordance with the appropriate governing criteria. In this circumstance, only two items will generally be required: a simple analysis update that takes into account all significant differences (in data, assumptions, etc.) between the previous study and the present study and a written record of the pertinent facts and conclusions, supported by an appropriately annotated copy of the documentation for the previous study and prepared in accordance with the provisions of paragraph 2-2d below.

## 2-2. General economic studies.

General economic studies are performed in response to the requirements of DOD 4270.1-M.

*a. Management considerations: Study scope and coverage.*

(1) *Scope of study effort.* The basic DOD requirement for LCC-based general economic studies (para 2-1a(l)) applies to all projects in the MCP. However, the scope of the economic study effort for each project will be determined individually, to insure the cost effectiveness of the study effort itself.

(2) *Coverage.* In a few specific types of design situations, an LCCA is required regardless of the cost-effectiveness potential of the study effort. These situations are as follows:

- Situations covered by special directives and requirements, such as those addressed in paragraphs 2-3 to 2-6.
- Situations in which the decision among design alternatives is heavily influenced by factors other than long-term economy; such factors may include strong user preference for a particular alternative and recommendations derived from value engineering studies or other cost-reduction initiatives.
- Situations that involve the consideration of an innovative design—for example, a design that is not provided for by current criteria or one that is not normally selected for the application being considered.

In these particular situations, an LCCA will be conducted unless the relative economic rankings of the various alternatives under consideration have already been established for similar design conditions. In all other situations, LCCA coverage will be determined primarily on the basis of cost effectiveness. Experience has shown that an LCCA of a design feature or facilities category that meets one or more of the following conditions is most likely to be cost effective in any given situation:

- The feature or category is itself cost intensive (i.e., high in LCC) relative to the project being designed, in terms of either initial construction/procurement costs or continuing costs that are incurred after the beneficial occupancy date (BOD)—especially the latter. Post-BOD continuing costs include fuel/energy, maintenance, custodial, and repair costs.
- The leading design alternatives for the feature or category are characterized by cash flows that are fundamentally different from each other (for example, one alternative has high initial costs and low post-BOD continuing costs, a second alternative has low initial costs and high post-BOD costs, and a third alternative exhibits a cash-flow pattern intermediate between the two).
- The feature or category is common to a number of projects, so that the LCCA results could be applied to several other projects in the MCP.

Accordingly, except as noted below, the economic study for all projects in the MCP will cover—as a minimum—all design features and facilities categories that meet one or more of these conditions.

(3) *Exceptions.* An LCCA *is not required* for a particular design feature if such analysis would be responsive *only* to the general requirements of DOD 4270.1-M and, in addition:

- It can be shown that the cost of the LCCA is likely to exceed any saving that could be achieved, even if the results of the study proved to be clear-cut; or
- The relative economic rankings of the various alternatives under consideration have already been established for similar design conditions; or
- The projected cost of studying the design feature, when added to the cost of LC-CAs already conducted or planned for other design features of the same project, would cause that total cost to exceed one

percent of the programmed amount for the project.

*b. Life cycle cost analysis.* The basic underlying principles and the most commonly used techniques of LCCA for facilities design are described in detail in a variety of readily available publications on the subjects of engineering economics and LCCA. The basic criteria and standards that govern the application of these principles and techniques in response to the requirements of DOD 4270.1-M are presented in the subparagraphs that follow. Subparagraphs (1) through (6) establish the general parameters for the LCCA: the alternatives to be included in the analysis for any given design feature, in subparagraph (1); the basic analysis approach, in (2); the timeframe for the analysis, in (3); the time value of money to be used, in (4); the unit of measurement or monetary standard, in (5); and the form in which the results of the analysis are to be expressed, in (6). Subparagraph (7) deals with costs and other monetary considerations, including the treatment of inflation and cost growth, and subparagraph (8) deals with the project calendar and other timing considerations. The treatment of uncertainties is presented in subparagraph (9). Subparagraph (10) provides an overview of the key provisions of this paragraph.

(1) *Design alternatives.* All design alternatives that are determined to be feasible for the application at hand—and only those alternatives—will be considered in each LCCA. A design alternative is feasible for a particular application if it satisfies at least the minimum established requirements for the project and for the MCP as a whole; these include functional requirements, technical criteria, energy-conservation criteria, standards for environmental quality, land use, health, safety, security, and, where applicable, budget constraints.

(2) *Analysis approach.* Current and future cash flows will be combined, compared, and analyzed utilizing the present-worth (PW) discounting approach. The “present time” to which all costs will be discounted is the date on which the analysis period begins—the analysis base date (see para 2-2 b(3)(a) below).

(3) *Analysis period.* The analysis period is the period of time over which the LCC for each design alternative is to be determined. The date on which it begins is referred to herein as the analysis base date (ABD) or simply the base date. The date on which it ends is referred to herein as the analysis end date (AED).

(a) *Analysis base date.* The ABD will be taken to be the date of study (DOS), the date on

which the study is actually performed, in accordance with conventional practice.

(b) *Analysis end date.* The AED will be taken as the calendar date on which the projected economic life of the facility as a whole ends. However, because DOD envisions the economic life of most types of facilities and major facilities components to end on the order of 25 years after BOD for general planning purposes, projected values of the AED in excess of 25 years beyond the BOD must be justified in writing and for most types of studies must be approved by HQDA prior to use. Prior approval will not, however, be required for those types of studies for which the use of actual projected economic lives is specifically authorized by HQDA. When the economic life of any particular facility is projected to end less than 25 years beyond the BOD, the analysis period used for the LCC will be the period of time between the DOS and the date corresponding to the actual projected value of the economic life.

(4) *Time value of money.* The time value of money that will be used in all LCCAs is 10 percent per year. This rate, commonly referred to as the discount rate, is to be used with either standard interest formulas or tables to convert current cash flows and future cash flows to a common base for analysis. The prescribed annual discount rate of 10 percent should be viewed as the minimum "real" rate of return—i.e., the net rate of return, *over and above the rate of inflation*—to be achieved by public sector investments. The Office of Management and Budget, at the recommendation of the Joint Economic Committee of the Congress, has determined that withdrawal of investment capital from the private sector by taxation can be justified only when the capital is used to finance public-sector investments for which the real rate of return is at least equal to that achievable on the average in the private sector (estimated to be 10 percent).

(5) *Monetary standard.* All costs—both those initially established in accordance with the provisions of paragraph (7)(b) below and those escalated to the times they are actually incurred in accordance with the provisions of paragraph (7)(c) below—will be expressed in terms of constant dollars that reflect the purchasing power of the dollar on the ABD. Accordingly, the proper unit of measurement for all costs and other monetary considerations, the monetary standard for the LCCA, is constant ABD dollars.

(6) *Analysis results.* The results of the LCCA will be expressed as a set of net present worths—one for each feasible alternative. The net PW (or

net LCC) for an alternative is the difference between the sum of the PWs of all costs that would be incurred and the sum of the PWs of all monetary benefits that would be derived, if that alternative were implemented. Accordingly, the results of the LCCA will consist of a set of net PWs on the ABD, each expressed in constant ABD dollars.

(7) *Costs and other monetary considerations.* The LCCA must take into account, for each design alternative, all the costs that would be incurred and all the monetary benefits that would be accrued throughout the analysis period as a result of selecting that particular design alternative. Even costs (or benefits) that may not be directly associated with some particular design alternative must be included in the net cost estimate for that alternative, so long as the costs (or benefits) are attributable to that alternative. For example, when an LCCA is conducted to determine the most economical type of exterior wall for a certain building, the costs associated with heating and cooling the building over the analysis period, and in many cases the original cost of the heating-ventilating air conditioning (HVAC) system, must be included in the net LCC estimate for each wall type. Both the procurement cost and the operating cost of the HVAC system are attributable, at least in part, to the type of wall selected.

(a) *Types.* As a general rule, *relevance* and *significance* are the determining factors for including particular costs or monetary benefits in the analysis: A cost or benefit will be included if it is relevant to the facility under design and the design feature under analysis and its projected magnitude is significant in comparison to other relevant costs that are included in the LCCA. All costs that are expected to be incurred throughout the analysis period will at least be considered for inclusion in the LCCA. Initial procurement costs, energy and operating costs, and maintenance, custodial, repair, and replacement costs will be relevant and significant to almost all analyses. The relevance and significance of other types of costs (such as design and redesign costs, terminal costs, downtime costs, and functional-use costs) and of monetary benefits (such as salvage and other forms of income, cost reductions, and marketable by-products) will have to be established on a case-by-case basis. Sunk costs (costs incurred prior to the analysis base date) are not relevant to LCCA results and will, therefore, not be included in the analysis.

(b) *Data sources.* Construction and other initial procurement costs will be determined in

accordance with existing MCP cost engineering criteria, guidance, and design practice, with two exceptions: There will be no allowances for contingencies or for supervision and administration (S&A) costs, and all costs will be expressed in terms of "ABD dollars" (and not in terms of program year or construction year dollars). Operating costs associated with fuel/energy consumption will be based on the results of an energy analysis. Other types of operating costs, maintenance-type costs (i.e., maintenance, custodial care, repair, and replacement costs), and other costs of ownership, as well as the times at which such costs are likely to be incurred, will be determined on the basis of the best available information at the time the LCCA is conducted. In many cases, the type of information required will be difficult to obtain from an independent and reliable source, in a form that is useful to the designer. As a result, the best available information obtained from any single independent source often will be no better than a "best guess." Consequently, the data used in the typical LCCA will have to be "constructed" from information gleaned from a variety of sources. Possible sources include the Directorate of Facilities Engineering (DFE)/Directorate of Engineering and Housing (DEH) staff, other facilities engineers, technical consultants, colleagues and other design professionals with previous experience in the area, manufacturer/industry representatives and literature, handbooks, trade-journal articles, Government publications, and technical articles, etc. The sources most appropriate for any particular application will have to be determined on a case-by-case basis. Regardless of the data/information sources actually used, all costs will be initially estimated as if they were to be incurred on the ABD, so that they are expressed in terms of ABD dollars, in accordance with the provisions above. Maintenance-type cost data that are constructed (rather than measured from historical data) will be consistent with all applicable Engineered Performance Standards and based on assumed standards of performance, cleanliness, aesthetics, etc., that are the same for all alternatives under consideration.

(c) *Inflation and cost growth.* The rate of inflation of the economy as a whole will be neglected in all LCC calculations. (The inflation rate is irrelevant to the LCCA results, because all cash flows are expressed in constant ABD dollars and discounted according to a "real" rate of return which reflects the time value of money over and above inflation.) Accordingly, in projecting future costs, an allowance for cost growth will

be made only for particular costs that are expected to change at rates greater than or less than the general rate of inflation. In such a case, the rates of cost growth used in the analysis will be *differential* rates of growth—that is, the anticipated difference between the growth rate of each particular cost and the general inflation rate. In general, in the absence of reliable information to the contrary, the differential rate of cost growth will be assumed to be zero. In the case of fuels and electricity, however, the differential rate of cost growth should be that prescribed by HQDA for general economic study applications.

(8) Project calendar and other timing considerations.

(a) *Project calendar.* The timing of all project events, i.e., the beginning, end, and midpoint of construction, the BOD, the dates on which cash flows occur, etc., will be based on the actual calendar dates on which the events are projected or scheduled to occur.

(b) *Continuing costs.* The present worth approach to LCCA is a cash-flow approach, in that in theory all costs are to be charged at the time at which they are actually incurred. In practice, the standard procedure is to accumulate continuing costs of the same type over some convenient period of time, and to charge all such costs incurred during that period as a single lump sum cost. Accordingly, all initial procurement costs will be accumulated and charged as a single lump sum cost, preferably at the time corresponding to the midpoint of the construction/procurement process. Similarly, all continuing costs of the same type incurred after the construction/procurement process is completed will be accumulated on an annual basis, beginning at the BOD, and charged as a series of single annual lump sum costs, preferably at the middle of the year (i.e., the first cost in the series charged six months after the BOD).

(9) *Uncertainties.* The input data for an LCCA are based on estimates rather than known quantities and are, therefore, uncertain. They may be uncertain as to the scope or quantity of things (e.g., pounds of steel, manhours of labor), the unit costs of things in the marketplace at the time the costs will actually be incurred, and the timing of cost (e.g., when a floor covering will require replacement). The effects of uncertainties on the results of an LCCA can be quite significant. They may distort the results of the analysis or dominate them so that one alternative may appear to be lowest in net LCC under one set of reasonable assumptions and highest in net LCC under another equally reasonable set of assumptions. For

these reasons, the need for uncertainty assessment will be considered as part of every LCCA.

(a) *Specific requirements.* The decision as to whether or not an uncertainty assessment is required for any particular LCCA will depend on a number of factors and so must be made on a case-by-case basis. Among these factors are: whether or not the LCCA results appear to be clear-cut; whether or not the relative economic rankings of the (apparently) top-ranked alternative and its nearest competitors could be affected by the results of the assessment; whether or not the LCCA results have to be approved by higher Command authority prior to implementation; and whether or not the LCCA results are likely to be controversial (as are deviations from criteria, changes from common practice, rejections of special user preferences, and significantly greater initial cost requirements that result in only marginal LCC savings). In general, an uncertainty assessment need not be performed if either of the following conditions applies:

- The relative economic rankings of the (apparently) top-ranked alternative and its nearest competitors cannot be affected by the results of the assessment.
- The LCCA results appear to be clear-cut—either clearly conclusive or clearly inconclusive—in advance.

In addition, even if the LCCA results appear not to be clear-cut—i. e., not clearly conclusive and not clearly inconclusive (especially the latter)—an uncertainty assessment is not considered necessary, provided the design decision is a routine one (i.e., one which may be implemented locally, without the need for higher-authority approval), and is one that is unlikely to be controversial when implemented.

(b) *Approaches.* Of the two leading approaches to uncertainty assessment, the probabilistic approach is the more direct and the more generally applicable for MCP designs, and it should be used whenever appropriate. Since the rigorous probabilistic approach is too complex for routine use, reasonable approximations to that approach are preferred for MCP design applications. The other leading approach to uncertainty assessment, the sensitivity approach, may be used in any situation in which the approach is valid; however, in all cases in which the probabilistic approach and the sensitivity approach are both valid, the probabilistic approach is to be preferred. In those situations where neither the probabilistic approach nor the sensitivity approach can be considered to be valid, uncertainty assessment may be accomplished by means of any common-sense heuristic approach—preferably one based on either the probabilistic or the sensitivity approach, or on some combination of the two.

(10) *Summary.* An overview of these provisions is provided in table 2-1, both for general summary purposes and for convenience in comparing these provisions with the corresponding provisions for special directed economic studies. The key provisions are as follows:

- Standard PW discounting (10 percent per OMB A-94; DOS base date).
- Costs measured in constant dollars (DOS dollars).
- Analysis period through economic life of facility (Limit: 25 years beyond BOD).
- Real future price level changes.
- No substantive artificialities (real project calendar; actual market prices).

Table 2-1. LCCA criteria overview: general economic studies for MCP designs

Category	Provisions
<b>BASIC CONSIDERATIONS</b>	
—Time value of money basis	Net terms
—Cost measurement basis	Constant dollars (base date)
<b>METHODOLOGY FEATURES</b>	
—Scope of costs & benefits	Dollar quantifiable, all attributable
—Cash flows	Conventional (mid-year accumulation of frequently recurring costs)
—Common time	Base date
—Uncertainties	Assessment required when critical to economic ranking order
—Special credits/penalties	None
—Results	Net LCC (PW)
<b>DATA &amp; PARAMETERS</b>	
—Discount Rate	10% net
—Base Date	Date of study
—Analysis period	Base date through economic life or 25 years from BOD (whichever is less)
—Inflation & cost growth	
<sup>0</sup> US economy	NA

Table 2-1. LCCA criteria overview: general economic studies for MCP designs—Continued

Category	Provisions
<sup>0</sup> Energy (avg. annual A )	Per HQDA
<sup>0</sup> Non-energy (avg. annual A )	Actual projections; 0% if uncertain
-Cost figures basis	
<sup>0</sup> Energy	Actual prices (base date)
<sup>0</sup> Other	Actual prices (base date)
-Project calendar	Actual projected timing

*c. Economic ranking of alternatives.*

(1) *General principles.* The alternative with the lowest calculated net LCC will be ranked most economical; the alternative with the next lowest net LCC will be ranked second; and so on, down to the alternative with the highest net LCC, which will be ranked least economical. If any alternatives are determined to have comparable net LCCs—either because their calculated net LCCs are essentially equal or because the uncertainties associated with the analysis are found to be sufficiently large to render apparent net LCC differences inconclusive—then their relative rankings will be based on a combination of energy-conservation and initial procurement cost considerations, as outlined below. For those situations in which the LCCA results appear not to be clear cut, the criteria for judging whether apparent net LCC differences are conclusive or inconclusive—and, hence, whether the LCCA results are conclusive or inconclusive—are as follows;

- A positive net LCC difference between two alternatives is conclusive if it can be shown that the probability of that difference exceeding zero is no less than 0.60.
- A positive net LCC difference between two alternatives is inconclusive if it can be shown that the probability of that difference exceeding zero is no greater than 0.55.

Finally, in the absence of net LCC determinations—either because an LCCA has not been conducted or because one has been conducted, but not in strict accordance with the criteria contained herein (e.g., it was not based on the best information available at the time) —design alternatives will be given economic rankings based solely on initial procurement cost considerations.

(2) *Tie-breaking.* If two design alternatives have comparable net LCCs, and it can be demonstrated with a high degree of confidence that one of these alternatives satisfies any of the following conditions, then that alternative will be assigned the higher relative ranking:

- It will be less expensive in terms of initial procurement costs *and* will consume no more fuel/energy per year; or

- It will consume less fuel/energy per year *and* will be no more expensive in terms of initial procurement costs; or
- It will consume at least 15 percent less fuel/energy per year *and* will not be more than 15 percent more expensive in terms of initial procurement costs; or
- It will be at least 15 percent less expensive in terms of initial procurement costs *and* will consume no more than 15 percent more fuel/energy per year.

When the two alternatives are of different fuel/energy types, quantities of fuel or energy consumed annually will be determined in Btu equivalents, measured at the source, in accordance with standard practice within the Department of Defense for measuring energy savings. If none of these conditions is satisfied, then the two alternatives will be assigned the same ranking. In those cases when two or more of the alternatives considered for any design feature are tied for the highest ranking, selection will be based on the designer's judgement as to which of the alternatives tied for the top ranking represents the best overall choice—in terms of initial cost, energy consumption, and life cycle cost—for the application at hand.

*d. Management considerations.* Documentation and distribution

(1) *Basic requirement.* A written record will be provided for every economic study, regardless of the size of the project and the conclusiveness of the results. The written record will be made a part of the design documentation and included in the project file.

(2) *Content.* The specific areas covered in the documentation will depend to a large extent on the nature of the study—for example, the type and scope of the project and the design feature(s) analyzed. For this reason, the coverage will have to be determined on a case-by-case basis. Every written record will, however, include and highlight the major technical and administrative lessons learned. The documentation should describe in essence what was done and how it was done, what information and data were used and their source, and the principal findings or results. The written record should be complete enough to

stand alone as a project document; it should be comprehensible to an audience that is not familiar with either the study itself or the MCP project for which the study was performed.

(3) *Distribution.* There is no general requirement regarding the distribution of the written records of economic studies. Rather, the desirability of distributing such material should be determined at the conclusion of each study. Distribution among the appropriate design professionals within the organization—for the purpose of exchanging information and data—is considered to be good professional practice and is encouraged in all cases. Written records are likely to be of interest or use relative to other MCP projects if they document significant or unusual findings, design decisions that represent changes from common practice, deficiencies in current criteria, significantly improved procedures, and so on. Such records should be brought to the attention of appropriate elements of higher authority within the Command, including HQDA where appropriate, for possible dissemination to other FOAs and/or other appropriate Command action.

### 2-3. Special energy-conservation studies—non-renewable resources.

Special economic studies required by statute for energy conservation—i.e., for the use of extraordinary energy-saving design initiatives to conserve energy in new Federal facilities—are addressed in part below and in part in paragraph 2-4. As indicated in paragraph 2-1 *b* (3) above, the focus in this paragraph is on those general efforts to conserve non-renewable forms of energy that are required of all new Federal facilities.

#### *a. Management consideration. Study scope and coverage.*

(1) *Requirement.* It is a statutory requirement that the selection of an energy-saving design (or design feature) for any new Federal facility be supported by the results of a special LCC-based economic study—one conducted in accordance with standard procedures and criteria specifically developed for this purpose under the FEMP. The criteria and standards presented throughout this paragraph are based on, and are completely compatible with, the criteria and standards which have been developed for the FEMP and (in accordance with the provisions of statute) included in the Code of Federal Regulations (CFR)—Title 10 (Energy), Part 436, Subpart A (10 CFR 436A). (The designations FEMP and 10 CFR 436A are used interchangeably herein.) It is important for the analyst to realize, however, that the nature of the FEMP material is such that it

requires periodic modifications and updating. This is particularly true for DOE projects of fuel-and-energy price-level changes (see paragraph 2-3b(7) below) and the analysis base date upon which these projections are based (see paragraph 2-3b(3) below)—criteria which DOE may be expected to update as frequently as once a year (perhaps more frequently). It is the specific FEMP criteria in effect at the time each study is initiated (or contracted for) that governs the conduct of that study. Up-to-date information on the DOE fuel-and-energy price-level projections and on all other aspects of the FEMP criteria that are current and in effect at any given time is available by request, through normal channels, to HQDA (DAEN-ECE-G), WASH, DC 20314-1000.

(2) *Application.* The statutory requirement—which is applicable to all energy-consuming elements of a facility, whether energized (e.g., chillers) or non-energized (e.g., exterior walls)—is considered to be limited to extraordinary energy-saving design initiatives. That is, it is considered to be applicable only to those special design situations where one or more of the design alternatives under consideration are being considered primarily for the extraordinary energy-saving potential that they offer in comparison with the more “conventional” energy-saving design alternatives that are already provided for by current general-purpose DOD/DA design criteria. In other words, the statutory requirement is applicable to special design situations devoted to energy conservation, where one (or more) of the design alternatives under consideration in an LCCA represents an extraordinary energy-saving design initiative (i.e., one not provided for by current criteria, or provided for, but only by special criteria developed specifically for purposes of energy conservation). On the other hand, the special statutory requirement does not apply to routine design-tradeoff decisions, in which the only types of alternatives considered in the LCCA are those provided for by current general-purpose criteria. (In such cases, the criteria of paragraph 2-2 above govern.)

*b. Life cycle cost analysis.* The criteria and standards prescribed in the FEMP for LCCAs conducted in support of extraordinary energy-saving design initiatives are presented in the subparagraphs that follow. Subparagraphs (1) through (6) establish the general parameters for the LCCA: the alternatives to be included in the analysis for any given design feature, in subparagraph (1); the basic analysis approach, in (2); the time frame for the analysis, in (3); the time value of money to be used, in (4); the unit of



measurement or monetary standard, in (5); and the form in which the results of the analysis are to be expressed in (6). Subparagraph (7) deals with costs and other monetary considerations, including the treatment of inflation and cost growth, and subparagraph (8) deals with the project calendar and other timing considerations. The treatment of uncertainties is presented in subparagraph (9). Subparagraph (10) provides an overview of the key provisions of this paragraph. (It will be seen that these criteria and standards are the same as those presented in paragraph 2-4b below—i.e., those for special energy-conservation studies that focus on the utilization of renewable energy resources.)

(1) *Design alternatives.* The design alternatives considered in an LCCA that is conducted in response to—or in conformance with—statutory requirements for energy conservation must include at least one extraordinary energy-saving design determined to be feasible for the application at hand and at least one feasible ‘‘conventional’’ design. In the typical situation, one to three energy-saving designs are considered, along with one ‘‘conventional’’ design—generally the ‘‘best’’ one, the one found to be most economical (i.e., highest ranked), in accordance with the provisions of paragraph 2-2 above. (Accordingly, the ‘‘conventional’’ design alternative is often referred to, and treated as, the ‘‘baseline alternative,’’ against which the various energy-saving alternatives are compared.) The criteria normally used to establish the feasibility of an alternative for a particular design application can be found in paragraph 2-2b(1) above. These criteria apply in energy-conservation LCCAs as well, except that—in the case of an extraordinary energy-saving design initiative—feasibility generally may not be denied either on the basis of budget constraints (i.e., the CWE will exceed the programmed amount, if the design in question is implemented) or on the basis of criteria limitations (i.e., the design is not provided for by current DOD/DA criteria), or both. Such a design, so long as it is judged to be feasible in all other respects, may generally be rejected only on economic grounds, in accordance with the provisions of statute. It should be noted that the types of energy-saving designs included in the LCCA need not be limited to the types addressed in this paragraph—i.e., those utilizing non-renewable forms of energy (primarily). Should the designer find it convenient and desirable to do so in any particular case, one or more alternatives of the types addressed in paragraph 2-4 could be included as well.

(2) *Analysis approach.* Current and future cash flows will be combined, compared, and analyzed using the present-worth (PW) discounting approach. The present time to which all costs will be discounted is the date on which the analysis period begins—the analysis base date (see para 2-3 b(3)(a) below).

(3) *Analysis period.* The analysis period is the period of time over which the LCC for each design alternative is to be determined. The date on which it begins is referred to herein as the analysis base date (ABD) or simply the base date. The date on which it ends is referred to herein as the analysis end date (AED).

(a) *Analysis base date.* The date to be used as the base date for the analysis is specified by the FEMP criteria and is included in 10 CFR 436A. This date is, however, subject to periodic updating, and it is the specific date prescribed for the FEMP at the time the study is initiated (or contracted for) that is to be used in each case as indicated in paragraph 2-3a(1) above. (The date specified by the FEMP criteria as the base date for the analysis—i.e., the first day of the base year—corresponds to the effective date of the fuel/energy prices cited in the criteria, and so is updated each time the FE MP-based fuel/energy prices are updated.)

(b) *Analysis end date.* The analysis period extends from the base date over a period of time that constitutes the projected economic life of the facility as a whole or 25 years, whichever is less. Accordingly, the AED will follow the base date by an amount of time equal to the economic life of the facility or 25 years, whichever is less.

(4) *Time value of money.* The time value of money will be taken as 7 percent per year. This rate, commonly referred to as the discount rate, is to be used with either standard interest formulas or tables to convert current and future cash flows to a common base for analysis. The prescribed annual discount rate of 7 percent should be viewed as the minimum ‘‘real’’ rate of return—i.e., the net rate of return, over and above the rate of inflation—to be achieved by public-sector investments for energy conservation.

(5) *Monetary standard.* The provisions of paragraph 2-2b(5) apply without exception.

(6) *Analysis results.* The provisions of paragraph 2-2b(6) apply without exception.

(7) *Costs and other monetary considerations.* The provisions of paragraph 2-2b (7) apply, with the following exceptions:

- *Data sources.* In accordance with the provision of statute, all fuel/energy costs eventually are to be expressed in terms of

“marginal” costs, as defined by the FEMP criteria, rather than in terms of actual market prices. However, until such time as marginal costs can be defined, developed, and published in the Federal Register for implementation by all Federal agencies, the interim approach prescribed by 10 CFR 436A will be used. The interim approach consists of two parts: One part prescribes that the actual market prices be used when the average annual costs of fuel/energy are estimated initially, and that the market prices will be those in effect on the base date. The other part prescribes that a 10 percent credit will be applied to all energy-conservation investments, to compensate for the fact that marginal fuel prices are not being used. (The proper way to apply the prescribed investment credit is to consider the initial investment cost of *each* alternative, for purposes of the analysis, to be 90 percent of the dollar cost amount actually estimated. This approach gives the desired effect.)

– *Data sources.* The nature of the FEMP-prescribed base date is such that the date on which the study is conducted will nearly always occur at some time later than the base date. In those situations where the time between the ABD (i.e., the most current prescribed ABD) and the DOS is substantial, and where—because of this—the designer/analyst would experience considerable difficulty in obtaining market prices in effect on the ABD, as required, the designer/analyst may use DOS market prices instead of ABD market prices in determining cost estimates initially (i.e., prior to escalation and discounting). Two conditions will be satisfied whenever this approximation is used, however: (1) DOS market prices will be used as the basis for *all* cost determinations in the particular LCCA, and (2) the DOS-based costs will be treated in the analysis as if they were in fact ABD-based costs—i.e., as if they in fact reflected the purchasing power of the dollar on the base date.

– *Inflation and cost growth.* In the case of fuels and electricity, the differential rate of cost growth will be the rate prescribed for the FEMP for the DOE Region in

which the project is located at the time the study is initiated (or contracted for) as indicated in paragraph 2-3a(1) above. (The DOE Regions are shown in appendix C.) For all items other than fuels and electricity, the differential rate of cost growth will be assumed to be zero.

(8) Project calendar and other timing considerations.

(a) *Project calendar.* The timing of all project events will be measured relative to the analysis base date (i.e., the ABD as determined in accordance with the provisions of paragraph 2-3 b(3)(a) above). The beneficial occupancy date (BOD) will be presumed to be the ABD for purposes of the analysis. All events that are projected to occur between the DOS and the actual BOD—e.g., design and construction—will be presumed for purposes of the analysis to have occurred on the ABD. The dates of occurrence of all events that are projected to occur after the actual BOD—e.g., cash flows associated with fuel/energy and maintenance-and-repair (M&R) actions—will be presumed for purposes of the analysis to be those dates on which they would have occurred had the BOD in fact occurred on the prescribed base date. (For example, a cash flow that is projected to occur 5 years after the actual BOD will be presumed for purposes of the analysis to occur 5 years after the prescribed base date.)

(b) *Continuing costs.* The provisions of paragraph 2-2b(8)(b) apply, with one exception: The series of annual lump sum costs used to represent post-BOD continuing costs will be charged at the end of the year. (The single lump sum cost that represents all initial procurement costs is charged on the base date, since the midpoint of the construction/procurement process—according to the provisions of paragraph 2-3b(8)(a) above—is to be presumed to have occurred on the base date.)

(9) *Uncertainties.* Assessment of the effects of uncertainty on the results of the analysis is not required. However, such an assessment is permitted by the provisions of the FEMP criteria for uncertainties associated with the cost data (but not those associated with cost timing), provided that the assessment is made by means of a sensitivity analysis.

(10) *Summary.* An overview of the provisions of paragraph 2-3b is provided in table 2-2, both for general summary purposes and for convenience in comparing these provisions with the

corresponding provisions for general economic studies. The key provisions of paragraph 2-3b are as follows:

- Standard PW discounting (7 percent; special standardized base date).
- Costs measured in constant dollars (base date dollars).
- Analysis period through economic life of facility (limit: 25 years beyond BOD).
- Real future price level changes (fuel/energy only).
- Several substantive artificialities (e.g.: standardized project calendar; 10 percent investment credit/marginal fuel costs; — 3 percent discount “credit”; differential-escalation restriction for non-energy cost elements; and uncertainty-assessment restriction).

Table 2-2. LCCA criteria overview: special energy-conservation studies

Category	Provisions
<b>BASIC CONSIDERATIONS</b>	
—Time value of money basis	Net terms
—Cost measurement basis	Constant dollars (base date)
<b>METHODOLOGY FEATURES</b>	
—Scope of costs & benefits	Dollar quantifiable only
—Cash flows	Post-BOD: conventional (end-of-year accumulation of all costs) Pre-BOD: on base date
—Common Time	Base date
—Uncertainties	Assessment not required; sensitivity study permitted, but on cost data only
—Special credits/penalties	10% investment credit for energy-saving designs*
—Results	Net LCC (PW)
<b>DATA &amp; PARAMETERS</b>	
—Discount rate	7% net
—Base date	Per HQDA
—Analysis period	Economic life, not to exceed 25 years
—Inflation & cost growth	
<sup>0</sup> US economy	NA
<sup>0</sup> Energy (avg. annual A )	Per HQDA
<sup>0</sup> Non-energy (avg. annual A )	0%
—Cost figures basis	
<sup>0</sup> Energy	Actual prices (base date)*
<sup>0</sup> Other	Actual prices (base date)
—Project time parameters	Artificial keyed to base date

\* Interim provisions—see paragraph 2-3b(7)

*c. Economic ranking of alternatives.*

(1) *General principles.* The alternative with the lowest calculated net LCC will be ranked most economical; the alternative with the next lowest net LCC will be ranked second; and so on, down to the alternative with the highest net LCC, which will be ranked least economical. If any alternatives are determined to have equal or very nearly equal net LCCs, then those alternatives will be assigned the same ranking. It is a statutory requirement that the alternative determined to be most economical be incorporated into the facility in all cases.

(2) *Tie-breaking.* There is no FEMP-prescribed tie-breaking procedure for alternatives with equal or very nearly equal net LCCs. Accordingly, in those cases when two or more alternatives are tied for the highest ranking, selection will be based on the designer's judgment as to which of the alternatives tied for the top ranking represents the best overall choice—in terms of

initial cost as well as energy consumption—for the application at hand.

*d. Management consideration.* Documentation and distribution. The provisions of paragraph 2-2d apply without exception.

2-4. Special energy-conservation studies—renewable resources.

Special economic studies required by statute for energy conservation—i.e., for the use of extraordinary energy-saving design initiatives to conserve energy in new Federal facilities—are addressed in part below and in part in paragraph 2-3. As indicated in paragraph 2-1b(3) above, the focus in this paragraph is on those special efforts to utilize solar energy and other renewable energy sources—in a passive as well as in active sense—that are required specifically of MCP facilities.

*a. Management considerations.* Study scope and coverage.

(1) *Requirement.* It is a statutory requirement that design initiatives based on the use of solar energy or other renewable forms of energy be considered for all MCP facilities where such designs have the potential to save fossil-fuel-derived energy. In each case, the decision to select or reject such an energy-saving design, whether active or passive (or hybrid) in nature, must be based on the results of a special LCC-based economic study—one conducted in accordance with standard procedures and criteria developed for this purpose under the Federal Energy Management Program (FEMP), except where specifically modified for MCP applications by the provisions of statute. The criteria and standards presented throughout this paragraph are based on, and are completely compatible with, the criteria and standards which have been developed for the FEMP, and (in accordance with the provisions of statute) included in 10 CFR 436A. (The designations FEMP and 10 CFR 436A are used interchangeably herein.) It is important for the analyst to realize that the nature of the FEMP material is such that it requires periodic modifications and updating and to understand the implications thereof (see paragraph 2-3a(1) above).

(2) *Application.* The statutory requirement applies to all projects in the MCP and within those projects—to all design features that use significant amounts of fossil-fuel-derived energy.

*b. Life cycle cost analysis.* The criteria and standards prescribed in the FEMP for LCCAs conducted in support of extraordinary energy-saving design initiatives were presented in paragraph 2-3b above (and are not repeated here). In an LCCA conducted to be responsive solely to the special statutory requirement for energy conservation in MCP facilities (i.e., energy conservation by means of utilization of renewable resources), the design alternatives considered must include at least one feasible design concept that is essentially based on the utilization of a renewable energy resource, and at least one feasible design concept that does not utilize a renewable energy resource in any substantial way (i.e., it uses fossil-fuel-derived energy only). The typical LCCA considers one design of each type—(1) the “baseline alternative,” generally the most economical design (for the application at hand) not utilizing a renewable energy resource, and (2) the proposed energy-saving design, based on the utilization of a renewable energy resource, which is evaluated economically in comparison with the “baseline.” In any particular case, the “best” of the designs not making use of a renewable energy

resource may turn out to be a “conventional” design, or it may turn out to be an extraordinary energy-saving design found to rank higher economically than any of the “conventional” design alternatives. It is important to note that, in the course of studying the possibilities for energy conservation in the design of an MCP facility, the designer need not necessarily treat the LCCA addressed in this paragraph and the LCCA addressed in paragraph 2-3b above as separate LCCAs. The two LCCAs may be combined into a single LCCA—without violating any of the provisions of statute—should the designer find it convenient and desirable to do so for the particular project at hand.

*c. Economic ranking of alternatives.* For all energy-conservation studies for which no special ranking requirements over and above those FEMP have been imposed, either by the Congress or by any higher level of authority within the executive branch, the economic ranking of the alternatives in the LCCA may be determined and reported either in absolute terms or in relative terms, whichever is considered to be more appropriate or preferable for the situation at hand. Generally, absolute rankings—those established on the basis of the life cycle costs (and benefits) of the individual alternatives themselves—are considered to be more appropriate and preferable for the design-type LCCA (i.e., the tradeoff analysis, where all the alternatives under consideration are in competition for a single application, and only one—the most economical one—will be selected). Similarly, relative rankings—those established relative to some “baseline alternative,” in terms of the cost-and-benefit advantages (or disadvantages) of each of the other alternatives in comparison with the baseline alternative—are generally considered to be more appropriate and preferable for the investment-type LCCA (i.e., the incremental analysis, where the proposed investment opportunities are evaluated in comparison with a given situation, in order to determine the economic feasibility of each, regardless of whether the various investment alternatives are mutually exclusive or not). These are not hard-and-fast rules, however, and either approach may be used for any given application. The net LCC is the traditional ranking measure for the absolute-ranking approach, and it will be used whenever the absolute-ranking approach is selected. Although there are several ranking measures in common use in conjunction with the relative-ranking approach—e.g., the LCC savings to be provided, the savings-to-investment ratio (SIR), and the discounted payback period (DPP)—the

LCC-savings measure will be used whenever this approach is selected. (One or more of the other ranking measures may be used in any particular design situation—and will be, in all cases where there is a specific special requirement to do so—but the use of those measures will always be in addition to, and not in place of, the LCC-savings measure.) The economic ranking criteria that will be used in conjunction with the absolute-ranking approach are those cited in paragraph 2-3c above; the criteria that will be used in conjunction with the relative-ranking approach are presented below. It will be seen that the provisions of the two sets of criteria are conceptually identical—i. e., differences exist only in terms of the prescribed format in which the data are to be calculated and presented—so that the rankings of the alternatives considered will always be the same, regardless of which approach is used. In other words, since all four of the ranking measures addressed above (the three types under the relative-ranking approach—LCC savings, SIR, and DPP—and the net LCC for the absolute-ranking approach) are interdependent in all cases, ranking by any one of them is tantamount to ranking by all four.

(1) *Ranking measures.* The basic ranking measure for the relative-ranking approach is the LCC-savings measure. The LCC savings—which refers to the savings in net LCC, expressed in PW terms, which will be achieved by the facility in question if the proposed energy-saving design is adopted—will be determined directly from the results of the LCCA, by algebraically subtracting the LCC (PW) of the proposed energy-saving design from the LCC (PW) of the baseline alternative (i.e., the most economical design not making use of a renewable energy resource). Other leading ranking measures for the relative-ranking approach are the SIR and the DPP, both of which require some additional calculations beyond those of the LCCA. The numerator of the SIR will be determined by algebraically subtracting the PWs of all operating-and maintenance-type costs (including fuel/energy costs) of the energy-saving design from those of the baseline design. The denominator of the SIR will be determined by algebraically subtracting the PWs of all capital costs (including initial investment costs, major replacement costs, net terminal costs—i.e., demolition and disposal costs less salvage value—and so on) that are attributable to the baseline design from those attributable to the energy-saving design. The DPP will be determined as that period of time (measured in years from the BOD) which, if selected as the analysis period for the LCCA, would result in an LCC (PW) savings of zero. The

LCC-savings measure will be evaluated and documented whenever the relative-ranking approach is selected for use. The SIR and/or DPP measures will be evaluated and documented only in response to specific requirements for such information in certain special cases (e.g., the Congressional requirement for MCP facilities, established around 1980, that all three of the ranking measures addressed herein be evaluated and documented for all economic-feasibility LCCAs involving an active solar-energy system).

(2) *General principles.* The energy-saving design will be considered cost effective (in comparison with the baseline design) when the LCC (PW) savings is greater than zero and not cost effective when the LCC (PW) savings is less than zero. When the LCC (PW) savings is equal to zero, or very nearly equal to zero, the energy-saving design will be considered neither cost effective nor not cost effective. In terms of the other two ranking measures: the energy-saving design is cost effective when the SIR is greater than one or when the DPP—rounded up to the next whole number of years—is less than the analysis period of the LCCA (i.e., the criteria-based value of the analysis period, selected in accordance with the provisions of paragraph 2-3b(3) above); the energy-saving design is not cost effective when the SIR is less than one or when the DPP is greater than the criteria-based value of the analysis period; and, when the SIR is equal to one, or very nearly equal to one, or when the DPP is equal to, or very nearly equal to, the criteria-based value of the analysis period, the energy-saving design is neither cost effective nor not cost effective. Whenever the energy-saving design is determined to be cost effective, it must be incorporated into the design of the facility, or the facility may not be built, in accordance with the provisions of statute; conversely, when the energy-saving design is found to be not cost effective, it may not be incorporated into the design of the facility. (It should be clear (a) that the facility with the energy-saving design is *more economical* than the facility without the energy saving design (i.e., the baseline design) when the energy-saving design is determined to be cost effective, less *economical* when the energy-saving design is determined to be not cost effective, and *as economical* when the energy-saving design is determined to be neither cost effective nor not cost effective, and accordingly—(b) that the general principles cited are identical in concept to those of paragraph 2-3c(1) above.)

(3) *Tie-breaking procedure.* There is no statutorily prescribed procedure for those cases in

which the energy-saving design is determined to be neither cost effective, nor not cost effective. Accordingly, in such cases, the decision concerning whether or not the energy-saving design should be incorporated into the design of the facility will be based on the designer's judgment as to the better overall choice for the particular application at hand, all things considered (i.e., life cycle costs, initial costs, energy consumption, etc.)

*d. Management considerations.* Documentation and distribution. The provisions paragraph 2-2d apply without exception.

## 2-5. Special studies for innovative/alternative wastewater treatment technology.

*a. Management considerations.* Study scope and coverage. It is a statutory requirement that all new Federal wastewater treatment facilities make use of innovative or alternative treatment processes and techniques (such as recycle and reuse techniques and land treatment) unless the LCC of the innovative/alternative treatment facility exceeds the LCC of the most cost effective conventional facility by more than 15 percent. The requirement is considered to apply to all new construction of such facilities, unless a waiver is granted according to the provisions of the statute.

*b. Life cycle cost analysis.* In accordance with the provisions of statute, at least one of the wastewater treatment concepts to be evaluated in the LCCA should qualify as an option that uses innovative or alternative treatment processes and techniques. Furthermore, no such innovative/alternative treatment facility may be rejected from consideration (i.e., considered not feasible for the application at hand) solely on the basis of budget constraints. Subject to these two restrictions, the provisions of paragraph 2-2b apply without exception.

*c. Economic ranking of alternatives.* All conventional treatment concepts included in the analysis will be ranked in accordance with the

provisions of paragraph 2-2c. If two or more innovative/alternative treatment concepts are included in the analysis, these will be ranked solely on the basis of their LCCs: i.e., the innovative/alternative treatment concept with the lowest net LCC will be ranked the most economical, the concept with the next lowest net LCC will be ranked second, and so on. Finally, the net LCC of the top-ranked innovative/alternative treatment works will be compared with an amount equal to 115 percent of the net LCC of the top-ranked conventional option. If the net LCC of the innovative/alternative facility exceeds that amount, then the conventional wastewater treatment option will be ranked higher and selected. If, on the other hand, the net LCC of the innovative/alternative option is either equal to or less than that amount, then the innovative/alternative facility ranks higher and must be selected by law.

*d. Management considerations.* Documentation and distribution. The provisions of paragraph 2-2d apply without exception.

## 2-6. Special intra-DOD directed economic studies.

*a. Management considerations.* Study scope and coverage. Requirements for special economic studies are established from time to time by HQDA, or the Office of the Secretary of Defense; these studies have one-time or limited application in the MCP. Requirements that are limited to a single project or to several closely related projects in the MCP are transmitted by means of the design directive for the affected projects. Those that are limited to the projects in a single program year are transmitted through normal channels to all HQDA FOAs. Such requirements may be established for a number of reasons, as indicated in paragraph 2-1b(2). All special economic studies required by HQDA will be conducted as directed as to both scope and coverage.

*b. Life cycle cost analysis, economic ranking, and distribution.* The provisions of paragraphs 2-2b through 2-2d apply to special intra-DOD directed studies.